

MATHEMATICAL VS EMPIRICAL MEASUREMENT

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ABSTRACT. In this short paper I will put in evidence a problem nested in Ozawa's effort to block von Neumann's chains and in his attributing the wave-collapse to a interaction between systems. This suggests distinguishing sharply the mathematical world from the phenomenological one.

1. VON NEUMANN

Let us starting with Ozawa's own words:

The orthodox view [of the wave-collapse] confuses the time at which the outcome of measurement is obtained and the time at which the object is left in the state determined by the outcome. (...) it confuses the time just after the reading of the outcome and the time just after the interaction between the object and the apparatus. There is no causality relation between the outcome and the state just after measurement (...).¹

I agree with Ozawa on this point. Otherwise, we would have a regress at infinity, a sort of hegelian *odd* infinity as von Neumann points out:

(...) wir müssen die Welt immer in zwei Teile teilen, der eine ist das beobachtete System, der andere der Beobachter. (...) Daß diese Grenze [i.e. zwischen beide Systeme] *beliebig* tief ins Innere des Körpers des wirklichen Beobachters verschoben kann, ist der Inhalt des Prinzips vom psychophysikalischen Parallelismus (...)²

[...] we must always divide the world in two parts, the one being the observed system, the other the observer. (...) That this boundary [i.e. between the observed system and the observer] can be pushed *at will* deeply in the interior of the body of the real observer is the content of the principle of the psycho-physical parallelism (...)]³

Surely the word *beliebig* [at will] is the source of such problem. This way, the consciousness can enter in the description of a measurement. On the other hand, we must distinguish the *measurement* and the *reading* of this measurement; i.e. the entanglement of the object with the observer and the reading of this interaction by the experimenter. So, we can no longer assert that the mind causes the collapse, as the given collapse is occurred earlier.

As the japanese physician accurately demonstrates, the wave-collapse occurs in a

Date: June 2 2010.

¹[Oza03, p. 117].

²[vN32, pp. 223–224]. The italic is mine.

³[WZ83, p. 622]. The italic is mine. I corrected the original translation in two points.

time interval $t + \Delta t$, while the perception of this collapse is at $t + \Delta t + \tau$, interval in which the two systems (object and observer) can no longer be in a relation.

On the other hand, we can observe that exists only that is perceivable in a *phenomenon*. A measurement which is not perceived (by a reading) is not a real measurement. It is a logically possible interaction which doesn't belong to the reality. From the discrepancy between the above mentioned intervals⁴ Ozawa infers a difference between measurement and perceiving of this measurement. But it is a logical inference. How can someone experience a measurement without interact with it (with a reading)?⁵ And if this collapse is not experienceable, then we are making *meta*-physics (we are going *beyond* physics). Therefore, is not useful putting aside a non physical entity as the mind to leave room for something more abstract, as a measurement without reading, also if this *something* has a definite grade of mathematical reality.

Moreover, Masanao Ozawa doesn't answer the main question. The reading of a measurement is invoked to explain the collapse; now, if this cannot be more the cause of the collapse, what is the real cause? Apparently, the interaction between subject and object, but we have no direct experience of it. I prefer a mereological-nominalistic stance (à la Leśniewski) in which it is a *perceived* measurement in a given context to determinate the wave-collapse. Von Neumann *seems* adhering to this position, stating:

(...) die Erfahrung macht nur Aussagen von diesem Typus: ein Beobachter hat eine bestimmte (subjektive) Wahrnehmung gemacht, und nie eine solche: eine physikalische Größe hat einen bestimmten Wert.⁶

[(...) experience only permits statements of this type: an observer has made a certain (subjective) observation; and never any like this: a physical quantity has a certain value.]⁷

Obviously it is highly questionable the *subjective* character of our perception. Our perception is on the contrary *objective* in a phenomenological point of view. What is more objective than the fact that we have in front of us a *given and no other*

⁴We cannot eliminate τ from the interval $t + \Delta t + \tau$ putting it as 0, because as you shows, $\Delta t < \tau$ [Oza03, p. 116].

⁵One can interact with an object *without* knowing the result of this interaction. For example, an observer can know that he is interacting with an object, without knowing the eigen-state in which the object jumped. The observer knows that surely by *this* interaction the system-object jumped in an eigen-state $|\phi_i\rangle$ and that an observable \mathcal{O} must have in $|\phi_i\rangle$ an eigen-value λ_i . But the observer cannot, without a reading, know in *which* eigen-state the system is. Obviously, knowing the wave-function of the system, he knows too the amplitudes of the probabilities associated to its vectors, but this is only a mathematical (statistic) forecasting, not a perception. In this sense, the fact that at $t + \Delta t$ the system-object is in an eigen-state is only an *inference*.

⁶[vN32, p. 224].

⁷[WZ83, p. 622]. I substituted *experience only makes statements...* with *experience only permits statements...* inasmuch it is evident from the discourse that any statement which don't satisfy certain conditions is not *permitted*. In other words, a purely objective observation is impossible for von Neumann. It is against the real physical experience making objective (if possible) statements. It is an absurdity.

experimental set-up, built in a *given* way, with *given* pointers?

Using Bohr's own words:

(...) in actual experiments all evidence pertains to observations obtained under reproducible conditions and is expressed by unambiguous statements referring to the *registration* of the point at which an atomic particle arrive on a photographic plate (...).⁸

And:

(...) the problem of explanation that is embodied in the notion of complementarity suggests itself in our position as conscious beings and recalls forcefully the teaching of ancient thinkers that, in the search for a harmonious attitude towards life, it must never be forgotten that we ourselves are both actors and spectators in the drama of existence.⁹

Obviously, it is one thing asserting that reality must be confined to the realm of experience and one other asserting that the cause of the wave-collapse, which oughts to belong to our experience, must coincide with the act of registration of a measure. Ozawa successfully shows that this act cannot cause the collapse. But, where is, then, the real cause of this collapse? If this is the measurement, where is, ontologically speaking, this measurement?

Let us quote Max Planck:

(...) es ist unmöglich (...) daß die ganze bisherige Entwicklung der physikalischen Erkenntnis tatsächlich gerade auf eine möglichst weitgehende grundsätzliche Trennung der Vorgänge in der äußeren Natur von der Vorgängen in der menschlichen Empfindungswelt hinarbeitet.¹⁰

[(...) it is impossible (...) that the development of the knowledge in Physics until now aimed at a fundamental and radical division between the processes in the external nature and the processes in the human world of feelings.]¹¹

Being no clear distinction between subject and object, it is best adopting an *holistic* view and consider as fundamental the perceived phenomenon. I.e. there are not in reality subject and object as two clear distinct entities, but a relation which *founds* it. Subject and object are only in a relation, in a totally entangled *Gestalt*. The measurement seen as interaction is such a *Gestalt*. But not meaning that observer and object *enter* in relation, but that the relation *founds* relate and correlate. What it is this relation in the measurement? The totality of the experimental arrangement which permits speaking of measurement. A totality which lives in our perception and is made of perceiving devices and tools of measurement. This is the *kantian* position of Bohr which sees in the experiment the real cause of any result: the *a-priori*, a sort of *category* which makes possible speaking of measurements, particles, collapses and so on. A frame in which the observer arranges his experiences.

⁸[Boh48, p. 317]. The italic is mine.

⁹[Boh48, p. 318].

¹⁰[Pla14, p. 39].

¹¹The translations from this text are mine.

But it is the position of Leśniewski too which saw no *elements* or *sets*, but *parts* and *collections*. In reality, there is a body. We can imagine to split up it. If we continue in this process at infinity, we would arrive at points or elements. But, in reality, we stop us at an *Umgebung*, at a *little ball* not at a point.

This relation must be perceived, must be object of our perception. What could we say of something beyond our perceptions, our *Erscheinung*? Planck observes:

(...) was man messen kann, das existiert auch.¹²

[(...) what we can measure, that it exists.]

Meaning for *Messung* the act of measuring, the registration of measurement, not the measurement without observer. What a measurement could be without observer, I don't dare to say. We can restate Planck's quotation as follows:

$$(1) \quad \forall x(M(x) \rightarrow E(x))^{13}$$

With $M = \{x|x \text{ is measured}\}$ and $E = \{x|x \text{ exists}\}$. In other words, if x is measured, then x exists. So, if we have that $\neg M(x)$ (i.e. x is not measured), what can we conclude? Nothing. From $\neg M(x)$ it follows both $E(x)$ and $\neg E(x)$.

2. CONCLUSION

Summing up, we have faced two distinct questions:

- (1) the reading of a measurement cannot be the cause of the wave-collapse
- (2) attributing the wave-collapse to the interaction observer-object *before* the reading of the measurement stops von Neumann's chain

According to our opinion, Ozawa successfully demonstrates 1. We are not sure that stating 1 rules out completely the problem hidden in 2. That is, the rôle of the subject in the act of knowing. In particular, it is not clear the *phenomenological* correlate of the measurement.¹⁴ In absence of a precise phenomenological correlate of a measurement, we can infer that this process amounts to an *observation without observer*.

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¹²[Pla14, p. 38].

¹³We know that the *existence* is not a predicate. We mean for E a real, not only logical, existence. Leśniewski would write: $\forall x(x \varepsilon M \rightarrow x \varepsilon E)$. If x is measured, then x is an object ([Mié84, p. 385]).

¹⁴Of course, it is clear the *mathematical* correlate of the measuring process.

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